

A Bioeconomic Analysis of Management Alternatives to Control Sea Turtle Mortality In the Gulf of Mexico Shrimp Fishery

Wade Griffin

Department of Agricultural Economics, Texas A&M University, College Station, TX 77843-2124

John Ward

National Marine Fisheries Service, Southeast Regional Office, St. Petersburg, FL 33702

James Nance

National Marine Fisheries Service, Galveston Laboratory, Galveston, TX 77551

The five species of marine turtles listed as either endangered or threatened under the Endangered Species Act are an incidental harvest or bycatch in the Gulf of Mexico shrimp fishery. This shrimp fishery is based on an unlimited access common property resource, resulting in overcapitalization of the fishing fleet and generation of excessive levels of shrimp fishing effort. Overcapitalization of the shrimp fishing fleet and its accompanying level of fishing effort results in turtle bycatch and its associated mortality. Annual estimates have ranged from 11,000 turtle mortalities (Henwood and Stuntz 1987) to 44,000 turtle mortalities (National Research Council 1990) per year in shrimp trawls.

Under the authority of the Endangered Species Act, the preferred alternative of the National Marine Fisheries Service (NMFS) to reduce the incidence of turtle mortality associated with shrimp trawls was the adoption of a turtle excluder device (TED) in the shrimp trawl. The presently existing TED regulations were required throughout the Gulf of Mexico by 1991. If properly installed, the TED reduces the catchability of sea turtles by shrimp otter trawls; however, not without some shrimp loss.

Even with TEDs in place on shrimp vessels operating in in-shore, nearshore, and offshore waters of the Gulf of Mexico, elevated turtle strandings still occurred in Texas (statistical zones 18 to 21) and western Louisiana (W. Louisiana) (west of the Mississippi River, including statistical zones 13 to 17) during 1990, 1994, and 1995. As a result, NMFS conducted a consultation on the effects of the fishery on endangered species, as required by Section 7 of the Endangered Species Act. In November 1994, the consultation concluded that the elevated strandings were the result of intense nearshore shrimping effort in areas of high sea turtle abundance, as well as use of either ineffective or illegal TEDs. Consequently, NMFS proposed a management plan (R_TED) in March 1995 (and imposed as an emergency rule in May 1995) to increase restrictions on allowable TED gear in areas of elevated strandings, and subsequently to close statistical zones to shrimp fishing for 30 days if turtle strandings continued to exceed a defined level. In response to these emergency restrictions, the House Appropriations Bill for the Department of Commerce directed NMFS to "seek...recommendations and analysis..., including a detailed assessment of the economic impact on the affected shrimp fishing industry."

Since the adoption of the R_TED, three other management alternatives have been proposed for consideration. In April, LGL Ecological Research Associates, Inc. (LGL), under contract with the Texas Shrimp Association (TSA), completed a study of existing databases and developed an alternative (TSA/LGL) to the current management regulations (CMR) (Gallaway et al. 1995). LGL concurred with NMFS that elevated strandings documented during 1994 were the result of intensive nearshore shrimping effort. Subsequent discussions between NMFS and LGL resulted in an alternative proposal (LGLM) that modified the TSA/LGL. The third management alternative was developed by NMFS because data indicated peak strandings in nearshore waters three weeks prior to and following the Texas closure. NMFS proposed a temporary effort reduction management alternative (TER) to reduce effort in nearshore waters during these peak strandings.

The General Bioeconomic Fishery Simulation Model (GBFSM) (developed by Grant, Isakson, and Griffin 1981) was used to examine the effectiveness of the four proposed management alternatives. Initially, GBFSM was set at an equilibrium total fleet size with a given effort distribution based on actual shrimp fishery data from the period 1986-1989. These years were selected because the Texas closure was in effect only out to 15 miles, the 1-4 fathom white shrimp fishery was open to allow for the harvesting

of large white shrimp, and TEDs were not required. A 25-year simulation period was used to evaluate the effects of the current and proposed management regulations. Rent for each management regulation is discounted over the 25 years as the industry adjusts toward a new equilibrium position. Rents of vessel owners and crew were assumed to be zero in the fishery before regulations were introduced. The introduction of a regulation would disturb the industry equilibrium and negative or positive rents would be incurred. Negative rents would cause some shrimp vessels to leave the industry while positive rents would cause additional shrimp vessels to enter the fishery. The analysis consisted of comparing results of the simulation output for the CMR to the simulation output for the four proposed management alternatives. A shrimp loss to the fishery due to the use of prescribed TEDs of 6.75% per tow was assumed (Renaud et al. 1993).

The R_TED management alternative proposed by NMFS restricts the use of soft TEDs and bottom-opening hard TEDs in areas of elevated strandings and provides for subsequently closing statistical zones to shrimp fishing for 30 days if turtle strandings continue to exceed a minimum level (the 30-day closure was not considered in this report). For the R_TEDs proposed management alternative, fishing effort relative to the CMR does not change in W. Louisiana or Texas for any zone considered in this study (Table 1). The R_TED may reduce turtle mortality if top-opening, hard grid turtle excluder devices are more effective than soft or bottom-opening hard grid turtle excluder devices. Depending on the shrimp loss scenario, this proposed management alternative could result in an increase in net benefits of \$0.004 million (Table 2).

The TSA/ LGL proposed management alternative would limit the net size to 100 ft of total headrope in a turtle conservation zone (nearshore), allow TEDs of any type (soft, hard, etc.) to be acceptable, and allow nets in the offshore zone to be pulled without TEDs. Under this proposed management alternative in Texas and W. Louisiana, effort increases relative to the CMR in the nearshore (6% and 3%, respectively) and offshore (11% and 7%, respectively) (Table 1). Marine turtle mortalities in the offshore zone should increase because of an increase in real days fished and the elimination of the requirement to use TEDs in this zone. This proposed management alternative could result in an increase in net benefits of \$19.5 million relative to the CMR (Table 2).

The LGLM proposed management alternative modified the TSA/LGL by restricting vessels greater than 60 ft in length from fishing in the nearshore zone. Under the LGLM, nearshore effort

Table 1. Ratio of real days fished^a for the proposed management alternatives to the current management regulations (CMR).

Zone	TSA/LGL ^b	LGLM ^c	R_TED ^d	TER ^e
W. Louisiana				
Inshore	0.99	1.25	1.00	1.00
Nearshore	1.03	0.54	1.00	1.00
Offshore	1.07	1.60	1.00	1.00
All zones	1.03	1.14	1.00	1.00
Texas				
Inshore	1.00	1.03	1.00	1.01
Nearshore	1.06	0.10	1.00	0.68
Offshore	1.11	1.23	1.00	1.02
All zones	1.07	1.00	1.00	0.97

^aCalculated as the sum of real days fished over the 25-year period for the proposed management alternatives divided by the sum of real days fished over the 25-year period for the CMR.

^bTSA/LGL: TSA and LGL Proposed Management Alternative

^cLGLM: Modified LGL Proposed Management Alternative

^dR_TED: Restricted TEDs Proposed Management Alternative—presently in effect as an emergency regulation.

^eTER: Temporary Effort Reduction Proposed Management Alternative

Table 2. Differences in net present value of rents over 25-year simulation period (\$1,000) for changes from the current management regulations (CMR) to proposed management alternatives.

Zone	TSA/LGL ^a	LGLM ^b	R_TED ^c	TER ^d
W. Louisiana	10,534	64,118	-4	0
Texas	8,984	5,630	8	2,766
Total	19,518	69,748	4	2,766

^aTSA/LGL: TSA and LGL Proposed Management Alternative

^bLGLM: Modified LGL Proposed Management Alternative

^cR_TED: Restricted TEDs Proposed Management Alternative—presently in effect as an emergency regulation.

^dTER: Temporary Effort Reduction Proposed Management Alternative

Table 3. Ratio of real days fished^a for the proposed management alternatives to the current management regulations (CMR) during the period from the last week in April through the first week in August.

Zone	TSA/LGL ^b	LGLM ^c	R_TED ^d	TER ^e
W. Louisiana				
Inshore	0.99	1.18	1.00	1.00
Nearshore	1.02	0.67	1.00	1.00
Offshore	1.07	1.66	1.00	1.00
All zones	1.02	1.15	1.00	1.00
Texas				
Inshore	1.00	1.12	1.00	1.00
Nearshore	1.06	0.07	1.00	0.05
Offshore	1.11	1.23	1.00	1.33
All zones	1.05	0.99	1.00	0.98

^aCalculated as the sum of real days fished over the 25-year period for the proposed management alternatives divided by the sum of real days fished over the 25-year period for the CMR.

^bTSA/LGL: TSA and LGL Proposed Management Alternative

^cLGLM: Modified LGL Proposed Management Alternative

^dR_TED: Restricted TEDs Proposed Management Alternative—presently in effect as an emergency regulation.

^eTER: Temporary Effort Reduction Proposed Management Alternative

declined in W. Louisiana (46%) and Texas (90%), while offshore effort increased in W. Louisiana (60%) and Texas (23%) relative to the CMR (Table 1). Turtle strandings have been shown to increase during the three weeks prior to and immediately following the opening of the Texas closure in July of each year. If only this period is examined, then a 93% (Texas) and 33% (W. Louisiana) reduction in real days fished occurs in the nearshore zone (Table 3). The large increase in real days fished in the offshore zone could potentially increase turtle mortality in Texas and Louisiana since TED-equipped nets would not be required under this proposed management alternative. Total net benefits to Texas and Louisiana shrimp harvesters would increase by \$69.7 million under this management option (Table 2).

The TER, proposed by NMFS, would reduce turtle mortalities in the Texas nearshore zone by prohibiting fishing three weeks both before and following the Texas closure when marine turtle abundance is the highest. A 32% reduction would occur in overall fishing effort in the nearshore zone of Texas (Table 1). If only the period of the closure is considered, then a 95% reduction in real

days fished would occur (Table 3). However, under the TER, real days fished in the offshore zone of Texas increase 11% overall, and during the time of the six-week special closure. In the Louisiana nearshore zone, there is no change in days fished and no expected change in turtle mortality. This proposed management alternative could result in an increase in net benefits of \$2.8 million when compared to the CMR (Table 2).

None of the proposed management alternatives address the underlying common property problem that is generating the unacceptably high incidental takes of sea turtles by the shrimp fishery. That is, with clearly defined, enforceable property rights for shrimp in the sea, total shrimp fishing effort would be reduced, total net benefits to the nation would be increased, and the incidental harvest of sea turtles would decline. Without a rights-based fishery management alternative, positive net benefits would attract new fishing vessels into the fishery, causing effort levels to increase and further exacerbating the bycatch problem. In the case of negative net benefits, existing shrimpers would be forced out of the fishery without any increase in benefits to the nation. In either case, not addressing the common property problem in the shrimp fishery will cause managers to revisit the sea turtle bycatch and mortality problem in the future with more restrictive and costly regulations.

References

- Gallaway, B.J., J.D. Bryan, L.R. Martin, and J.G. Cole. 1995. Sea turtle and shrimp fishery interactions—Is a new management strategy needed? Report prepared for the Texas Shrimp Association by LGL Ecological Research Associates, Inc., 1410 Cavitt Street, Bryan, Texas, April. 79 pp.
- Grant, W.E., K.G. Isakson, and W.L. Griffin. 1981. A general bioeconomic simulation model for annual crop marine fisheries. *Ecological Modeling* 13:195-219.
- Henwood, Tyrrell A., and Warren E. Stuntz. 1987. Analysis of sea turtle captures and mortalities during commercial shrimp trawling. *Fish. Bull.* 85(4):813-816.
- National Research Council. 1990. Decline of the sea turtles: Causes and prevention. Draft report, Committee on Sea Turtle Conservation, Board on Environmental Studies and Toxicology, Board on Biology, Commission on Life Sciences, National Academy Press, Washington, D.C.
- Renaud, M., G. Gitschlag, E. Klima, A. Shah, D. Koi, and J. Nance. 1993. Loss of shrimp by turtle excluder devices (TEDs) in coastal waters of the United States, North Carolina to Texas: March 1988-August 1990. *Fish. Bull.* 91:129-137.